REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Science

MICROBIOLOGICAL REGIME AND MODERN ECOLOGICAL, SANITARY-HYDROBIOLOGICAL CONDITION OF THE MAIN RESERVOIRS OF AZERBAIJAN

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INTRODUCTION

Rationale and level of development of the research topic. *"It is known from ancient, written sources and documents that people created reservoirs and irrigation networks 4-5 thousand years ago to meet their water needs"* [1] and this problem-care has not lost its relevance so far. However, in modern times, hydraulic structures, including reservoirs, are created for various purposes. For example, to obtain energy, to create a basis for the development of the population, agriculture, industry, to develop fisheries, poultry, to improve the transport and communications, goods, cargo turnover, to attract additional land to agriculture, etc.

In Azerbaijan, located in the south-east of the Caucasus, there has been little water throughout history. *"Our country accounts for only 14% of water resources in the region. The reason is that natural evaporation in our area is 2.7-3 times higher than humidity".* [2] However, Azerbaijan has been an agrarian country since ancient times. *"That is why, before the time of Teymurlang, a dam called Govurarx was created and is still used today. The demand for water has also led to the creation of canals in Azerbaijan".* [3]

Thus, it is clear that water supply concerns have existed since ancient times, and therefore large-scale and complex hydraulic infrastructure facilities, reservoirs, irrigation and irrigation networks are being created in our country. Unlike other countries, including neighboring countries, most of the reservoirs created in Azerbaijan are irrigated and industrial in the basin.

In addition to its fields, it is also used as a main source for drinking in the home.

In the last 60-70 years, the main reservoirs in Azerbaijan have been established in the basin of the Kur-Araz rivers and are

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[1] Chaillian F., Chaineau C.H., Point V. et al. factors inhibiting bioremediation of soil contaminated with weathered oil and drill suttings // Environmental Pollution, 2006, v. 144, p. 255-2650.

[2] Rustamov S.G., Kashkai R.M. Water resources of the Azerbaijan SSR. Baku, Elm, 1989, 181 p.

[3] Geography of the Republic of Azerbaijan. Baku, 2014, l volume, p. 168-231

considered an invaluable source in densely populated areas and extensively developed agriculture (Shirvan, Mil, Mugan, Karabakh, etc.). *“At the same time, it is known that the Kur-Araz waters, which make up 70% of Azerbaijan's water balance, are used by 80% of the country's population, and these rivers, their main tributaries, have been heavily polluted for decades in Georgia and Armenia”.*[4]

"It should be noted that the first microbiological research in the reservoirs in Azerbaijan was conducted by M.A.Salmanov in the 50s of the last century in the Mingachevir reservoir."[5] It became clear that the vegetation of phyto-bacterioplankton in the reservoirs created on the rivers exposed to anthropogenic influences changes dramatically, there are ecological consequences in the physical and chemical properties of the water. Planned, complex, monitoring-oriented microbiological, sanitary-hydrobiological, ecological researches in reservoirs can be considered relevant. The main water created in Azerbaijan is the water of the Kura River in Georgia, and the Araz River and its main tributaries, which are highly polluted and poisoned by Armenia. reservoirs (river-reservoir ecosystems) determine the ecological, sanitary-hydrobiological condition, degree of saprobility, possibilities of self-purification of water created by them. Thus, it is possible to scientifically and practically correctly assess and predict the sanitary-hydrobiological safety of water collected in reservoirs for domestic, agricultural, industrial and processing purposes, without conducting the above-mentioned researches, seasons and factors together, without determining the course of substances in reservoirs.

Purpose and objectives. Thus, the following goals and objectives are envisaged to substantiate the protection of sanitary-hydrobiological and ecological stability of water resources in Azerbaijan:

- Determination of trophic type of main reservoirs in Azerbaijan;
- Substantiation of the formation of biological productivity by

[4] Aliev S.N. Microflora p. Curry and its role in the process of self-purification. Author's abstract. diss. sugar biol. science. Kiev, 1980, 23 p.

[5] Salmanov M.A. Primary products of Mingechaursky reservoir. DAN Azerbaijan. SSR, 1960, vol. 16, № 4, p. 401-405.

determining the primary product synthesized by phytoplankton in reservoirs, destructive organic substances;

- Calculation of organic matter balance in reservoirs;
- Determination of the current ecological condition of reservoirs based on the results of sanitary-hydrobiological and ecological microbiology;
- Assessment of self-cleaning of reservoirs;
- Determining areas of water use according to the results of the degree of saprobility;
- Substantiation of domestic use of reservoirs created in river channels in the country;
- Substantiation of the need to establish a sanitary protection zone along the Kura and Araz rivers in Azerbaijan.

The main provisions of the dissertation submitted for defence:

- For the long-term efficient use of the main water reservoirs of Azerbaijan,the number of microorganisms in its water and silt-soil is an important indicator of the number of total microbes, separate physiological groups and bacteria belonging to the genus coliform-enterobacter.
- In the pollution of the Kura-Araz basin of Azerbaijan,the waste water from domestic and communal economy, food products industry, as well as metallurgical and chemical industry, discharged both from outside the country, plays an important role.
- The biological productivity of phytobacterioplankton is a more reliable indicator for determining the amount of organic substances synthesized in reservoirs and introduced from outside.
- In modern times, finding new alternative sources of water use is important in terms of preventing the occurrence of anthropogenic eutrophication and increasing the efficiency of water use.
- The recommendations made during the use of water in various fields should be based on the determination of

saprobity, self-purification rate in water reservoirs,modern ecological and sanitary-hydrobiological indicators.

The scientific novelty of the research. For the first time in Azerbaijan, based on the results of microbiological, sanitary-hydrobiological and ecological research carried out in 10 major reservoirs, their trophic type, degree of saprobility, physical and chemical properties of water were determined.

The primary product of phytoplankton, which is the basis of the balance of organic matter in reservoirs, and the amount of destructive substrates were jointly studied. For the first time, a comparative, biological and ecological study of the systemic microbiological regime in reservoirs located in different climatic conditions of Azerbaijan was carried out. Biological productivity, the degree of self-purification of water, anthropogenic eutrophication and its ecological nature were studied. It was found that the water in the reservoirs created in the Kura and Araz rivers, which are heavily polluted in Georgia and Armenia, is polysaccharide and autoevtrophic.

It has been proven that phytoplankton flourishes in reservoirs enriched with biogenic elements, water is enriched with phytoncides, metabolic products of bacterioplankton and becomes unusable.

As a result of comparative studies, alternative reservoirs that are considered suitable for domestic use have been identified. Active strains decomposing petroleum hydrocarbons and phenols were obtained from pollutants that adversely affect hydrobionts in the studied basins.

Theoretical and practical significance of the research. The wide-ranging results, which are considered to be a combination of complex research, are a fact and evidence that scientifically and practically substantiate the effective use of reservoirs belonging to different ecosystems.

Organic balance, trophism, degree of saprobility of reservoirs, etc. The results obtained from the study of the issues can be used as a key recommendation in the protection, conservation and efficient use of water resources in Azerbaijan.

The results obtained due to the detailed study of the causes of anthropogenic eutrophication and the ecological contrasts caused by it justify the possibilities of preventing mass destruction of fauna and flora (anaerobiosis) in water reservoirs, developing hydrobionts that are important to the environment, especially fisheries.

Based on hydrochemical, toxicological, complex microbiological and sanitary-hydrobiological research, for the first time, fully suitable sources for domestic use are offered. Active culture strains that can be used to treat wastewater with oil and phenols have been obtained.

Publication, approbation, and application of the dissertation. The main results and provisions of the dissertation were presented at the following conferences-seminars: II-Caspian International Conference on Water Technologies (Baku, 2014); Seminar of the Institute of Microbiology of ANAS (Baku, 2015); Problems of Azerbaijani regions (Baku, BSU, 2016); Actual problems of modern biology and chemistry, International e / k. (Ganja State University, 2016); Environmental problems of Azerbaijan and prospects of production of clean agricultural products, International e / k. (Ganja, 2015); Water problems and technologies, International e / k. (Baku, 2016); Problems of modern natural sciences, International e / k. (Ganja, 2017); 100th anniversary of Shollar-Baku water facilities complex - International e / k. (Baku, 2017); Ecological eutrophication in Astana reservoirs, seminar of the Institute of Microbiology of ANAS (Baku, 16.10.2017); Environmental problems of the southern Caspian basin, International e / k. (Makhachkala, 2017). Scientific-practical conference dedicated to the 90th anniversary of the corresponding member of ANAS, professor Demir Vahid oglu Hajiyev (Baku, 2019); International conference dedicated to the 100th anniversary of the Department of Human Anatomy and Medical Terminology of Azerbaijan Medical University conference (Baku-2019), was presented at the International Congress "Actual Problems of Medicine" (Baku-2021), dedicated to the 100th anniversary of Professor Tamerlan Aliyev.

Publications. 48 scientific works (1 monograph) on the topic of the dissertation were published.

The structure and scope of the dissertation. The dissertation consists of 6 chapters: introduction, literature review, materials and methods, general conclusion, results and bibliography (305). The volume of the work is 289 pages, the actual results are presented in 125 tables and 16 cartoons. The dissertation consists of 245 computer pages (483142 symbols in total), including tables and figures.

LITERATURE REVIEW

CHAPTER I
ABOUT WORLD RESERVOIRS
GENERAL INFORMATION

This chapter provides information on the history of the development of society in the world, including in Azerbaijan, the creation of reservoirs, irrigation networks and other hydraulic structures created to meet the demand for water.

CHAPTER II
MATERIALS AND METHODS

Research and observations were conducted in the main (10) reservoirs created in Azerbaijan in 2012-2017 – Mingachevir, Shamkir, Yenikend, Varvara, Agstafachay, Shamkirchay, Arpachay, Nakhchivan, Yekakhana and Ashig-Bayramli, according to the seasons. Sampling was carried out based on the selection of a planned route and permanent sites, preparation of samples for laboratory analysis, microbiological analysis of water samples to *"known methods"* mainly implemented. Water samples were taken by YI Sorokin for microbiological analysis, and by Knudsen batometer for hydrobiological-hydrochemical analysis. Sludge-soil was obtained by QOIN pipe-device. The main biogenic elements in the water, some heavy metal salts and other pollutants were identified by Palintes THM Digital and O_2 by Milwaquke MW 600.We used the G.G.Vinberg method to calculate the primary product of phytoplankton and the organic matter being destroyed.

Microbiological analysis, plantings *“V.I.Romanenko”* [6] *“S.I.Kuznetsov”*[7] and *“A.G.Rodina”*[8] and methodical instructions of *“S.N.Vinogradsky”*[9].

Bacteria that break down petroleum hydrocarbons and phenols were determined by the Voroshilova-Dianova method.

In the years of research (by seasons) 1897 water, silt-soil samples were collected and 5310 analyzes were carried out using these samples. All figures obtained are statistically processed.

CHAPTER III
IN THE MAIN WATER RESERVOIRS OF AZERBAIJAN PRIMARY PRODUCT OF PHYTOPLANKTON and GENERAL DESTRUCTION OF ORGANIC SUBSTANCES

The role of phytoplankton in the life of water bodies - in the formation of the energy source of all hydrobionts involved in the metabolism, the formation of biological products, the regulation of gas-salt regimes and other physicochemical processes in ecosystems is very large. *"Also, some types of phytoplankton are used as ecological and biological indicators in the solution of issues of sanitary-hygienic, ecological assessment of reservoirs, large-scale use of water."*[10]

1. Phytoplankton in Mingachevir reservoir primary product and destruction of organic matter

Mingachevir reservoir borders the Middle Kura and the Lower Kura stream - was established in 1953 at the intersection of the Bozdag range. *"Its area is 600 km^2, length 75 km, reservoir - 16 km^3,*

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[6] Romanenko V.I. Bacterial decomposition of organic matter in reservoirs. Microbiology, 1987, v. 46, no. 1, p. 123-127.

[7] Kuznetsov S.I. Ecology of microorganisms of fresh water bodies (laboratory guidance). M., "Nauka", 1974, 194 p.

[8] Rodina A.G. Methods of aquatic microbiology. M., "Nauka", 1965, 364 p.

[9] Vinogradsky S.N. Methods of soil microbiology. M., 1953, 140 p.

[10] Romanenko V.I. Microbiological processes, products and destruction of organic matter in internal waters. M., Nauka, 1985, 295 p.

maximum width - 20 km, 9 km average width, 75 m depth."[11] The amount of phyto-bacterioplankton primary product in Mingachevir reservoir has changed many times in the last 60 years. *"If until the 1980s the reservoir was of the mesotrophic type, for the last 35 years it has been characterized as an eutrophic basin ."*[12]

However, after the establishment of the Shamkir (1982) and Yenikend (2000) reservoirs, the inflow of clear water into the Mingachevir reservoir increased its 20 kmwater transparency fivefold in its largest area, the Kura, Gabiri and Ganikh river valleys. This, in turn, paved the way for the development of phytoplankton.

Table 1

Average annual primary yield and destruction of water transparency (m), phytoplankton in Mingachevir reservoir in 1962-2015. Quantitative change of organic matter (mg C / l)

Station	1962			1984			2015		
	transparent. m	IM[1]	D[2]	transparent. m	IM	D	transparent. m	IM	D
1	0.4	0.36	1.80	1.4	2.8	3.40	2.70	9.60	6.70
2	0.5	0.39	1.60	2.0	2.30	2.60	2.40	10.20	6.30
3	0.5	0.40	1.70	1.3	2.60	3.00	1.80	8.70	5.80
Medium	0.5	0.38	1.70	1.60	2.60	3.00	2.40	9.3	6.2

Note: 1. IP - primary product; 2. D - destruction;
3. All results were statistically processed and P ≤ 0.46.

Therefore, the euphotic-trophogenic layer in the reservoir is now deeper (Figure 1).

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[11] Tarverdiev R.B. Establishment of Mingachevir Reservoir. Baku, Elm, 1974, 155 p.

[12] Manafova A.A. The growth of micro-mice-migrants identified in the waters of the Mingachevir reservoir for oil and oil products // Ecological Conference, Riga, 1991, p. 135-136

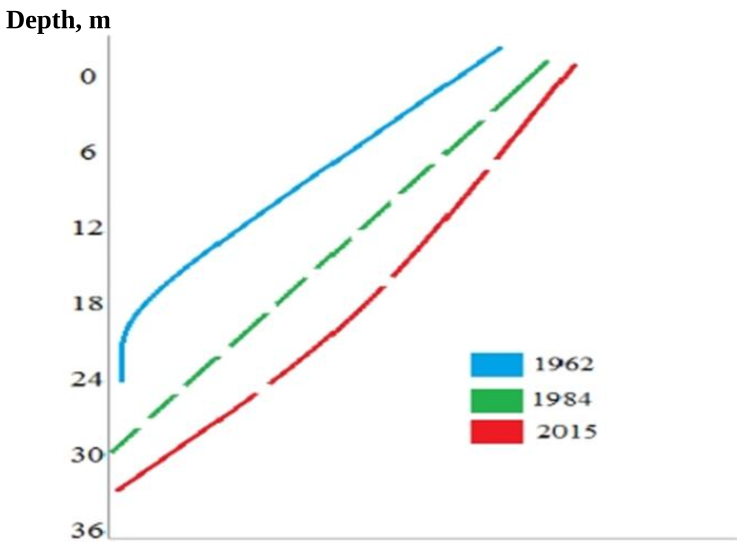

Fig. 1. Trophogen in Mingachevir reservoir layer change

The fact that the process of eutrophication in the Mingachevir reservoir has been gradually increasing over the last 50 years, year by year, is clearly visible in the summer (Table 2).

Table 2

Comparison of primary production of phytoplankton in Mingachevir reservoir in 1962, 1984 and 2015 (summer season, mgC / l)

Station	1962	1984	2015 *
1	0.34	1.90	9.60
3	0.40	2.20	10.20
5	0.80	2.60	8.70
7	0.90	1.90	9.10
8	1.00	2.10	11.00
9	1.10	4.30	12.40
10	1.30	5.10	11.60
11	1.50	5.80	12.10
12	1.60	7.80	13.70
13	1.40	8.10	14.30
Medium	1.00	4.20	11.20

Note: * - All results were statistically processed and $P \leq 00.47$ increased.

It is clear from Table 2 that the initial production of phytoplankton in the Mingachevir reservoir has increased 11 times in the last 53 years (summer months).

It should be noted that the Mingachevir reservoir contributes to the ecological stability of the biosphere of Azerbaijan and, finally, the health of millions of people, etc. is the largest source of water that is directly related to the problems. Therefore, complex studies in the Mingachevir reservoir should be repeated from time to time. We must not forget that the Lower Kura starts from the Mingachevir reservoir. It is clear from the results of repeated studies that in the Mingachevir reservoir the initial yield of phytoplankton increased several times (Figure 2). Thus, it turns out that anthropogenic eutrophication in the Mingachevir reservoir is intensifying from year to year, the water is constantly polluted with phytoncides and other metabolites.

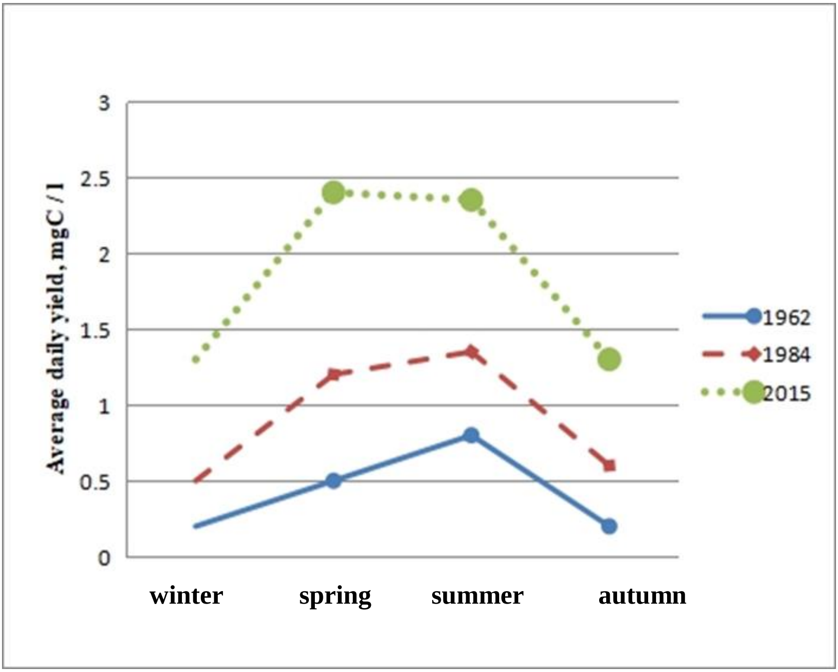

Fig. 2. Primary phytoplankton in Mingachevir reservoir change of product from year to season comparison

It became clear that the amount of organic matter destroyed in the Mingachevir reservoir at all times (Table 3) has increased more than 8 times in the last 53 years (summer months). This also means that the reservoir contains organic substances of alloxton origin continues to be brought in by rivers from abroad. It should be noted that the calculation of the balance of organic matter in reservoirs (reservoirs) is not carried out by every researcher. To do this, comprehensive research should be completed in the seasons. According to our complex research, trophic status and biological productivity in reservoirs have been calculated. Thus, for the first time, the balance of organic matter in the Mingachevir reservoir was determined.

Table 3

Primary product of phytoplankton in Mingachevir reservoir and changes in the average daily values of degraded organic matter (mg/l, summer)

Stantion	1962		1984		2015 *	
	primary product	destruction	primary product	destruction	primary product	destruction
1	0.34	0.60	1.90	2.60	9.60	11.30
3	0.40	0.83	2.20	2.20	10.20	12.40
5	0.80	0.90	2.60	2.20	8.70	9.70
7	0.90	1.60	1.90	3.40	9.10	13.60
9	1.10	1.90	4.30	5.80	7.10	8.80
11	1.50	2.00	5.80	6.30	12.40	14.30
13	1.40	2.90	5.10	6.20	14.30	16.40
Medium	0.91	1.52	3.81	4.00	10.20	12.60

Note: * - All results were statistically processed and $P \leq 0.048$.

It is clear from the table that currently 414,000 tons of organic matter is formed in the Mingachevir reservoir per year, 555,000 tons of organic matter is mineralized, which is 1.4 times or 155,000 tons more than the income of the organic matter balance.

Table 4

Balance of organic matter in Mingachevir reservoir (2015)

Coming sources	thousand t/C	%	Subtract - spent	thousand t / C	%
Alloxton organic substances	18.0 ± 0.8	6.3	Destruction in water	457 ± 2.0	70
Primary product	414.0 ± 18	93.7	Destruction in silt	97.7 ± 4.5	30
Total	432.0	100	Total	554.7	100

2. Primary of phytoplankton in Varvara reservoir product and destruction of total organic matter.

Varvara reservoir was established in 1956 in the lower bay of Mingachevir reservoir. Its area is 22.5 km^2, reservoir - 60 million m^3 Wastewater from Mingachevir city and neighboring villages and settlements is discharged into the Varvara reservoir: the right bank is the Kura channel, the left is a wide, shallow area, and the lake is considered an “water” area. Therefore, all indicators on the left bank are 3-4 times higher than on the right bank, and the initial yield of phytoplankton is increasing year by year.

Table 5

The first of the phytoplankton in the Varvara reservoir Quantitative change of product by years (mg C / l)

Area	**Winter**		**Spring**		**Summer**		**Autumn**	
	1 1984	**2 2015**	**1 1984**	**2 2015**	**1 1984**	**2 2015**	**1 1984**	**2 2015**
Top	0.23	0.46	0.30	0.60	0.44	0.90	0.40	0.70
Medium	0.25	0.55	0.34	0.86	0.57	2.00	0.50	1.60
Down	0.36	0.90	0.60	1.60	0.93	3.80	0.70	3.50
Left bank	0.45	1.30	0.65	2.80	2.80	4.40	2.80	4.60
Medium	0.33	0.80	0.47	1.45	0.93	2.75	1.10	2.60

Note: All results were statistically processed and $P \leq 0.048$.

The balance of organic matter in the basin is presented in Table 6, and it is clear that the Varvara Reservoir generates 16.4 thousand tons of organic matter per year and 20,000 tons are mineralized.

Table 6

Balance of organic matter in Varvara reservoir (2015)

Sources of income	thousand tons / C	%	Subtract - spent	thousand tons / C	%
Alloxton organic substances	2.00 ± 0.1	14.0	Destruction in water	15.5 ± 0.7	77.5
Primary product	14.4 ± 0.5	86.0	destruction in silt	4.5 ± 0.2	22.5
Total	16.4	100	Total	20.0	100

3. Primary product of phytoplankton in Shamkir reservoir and destruction of common organic matter

Shamkir reservoir was established in 1982. It has an area of 116 km^2, a volume of 2.7 km^3, a maximum depth of 60 m, a length of 40 km, an average width of 3 km and an advantageous volume of 1.43 km^3.

Typically, the Shamkir Reservoir is the largest "sedimentary sediment" in the upper bay (mainly in Georgia-Armenia), which is the first to receive heavily polluted water. According to R.A.Ismayilov, 20,000 tons of mineral nitrogen-phosphorus compounds are brought to the Shamkir reservoir annually by the Kura River (2013). For this reason, although 32-33 years have passed since the establishment of the Shamkir Reservoir, the processes of enrichment and biodegradation of organic matter in the basin have not stabilized (Table 7).

Table 7

Primary product of phytoplankton in Shamkir reservoir and biodegradation indicators of organic matter (mg C/l - per day) change by years (summer)

Stations	Primary product				Biodestruction			
	1985	1990	2000	2015	1985	1990	2000	2015
1	0.30	0.51	0.63	0.82	1.20	1.66	2.60	3.10
2	0.26	0.64	0.84	1.60	1.50	2.40	3.20	4.30
3	0.84	0.96	1.20	2.36	1.25	2.10	3.10	3.90
4	0.40	1.10	1.66	3.10	-	-	-	-
5	1.25	2.40	3.00	4.46	1.48	2.35	3.00	4.20
6	1.46	2.20	2.80	4.30	1.20	2.30	2.80	3.10
7	1.50	2.60	3.10	4.40	1.80	2.50	3.30	4.10
8	1.66	2.50	3.00	4.70	1.90	3.60	4.70	5.10
9	1.40	2.10	2.40	4.10	2.00	3.90	4.90	5.70
Medium	1.00	1.70	2.10	3.40	1.60	2.50	3.50	3.80

The balance of organic matter in the basin for 2015 was calculated: the initial yield of phytoplankton - 82.8 thousand tons C, and the total amount of organic matter destroyed in water and silt - 101 and 28 thousand tons C, respectively.

4. Primary product of phytoplankton in Nakhchivan reservoir and destruction of common organic matter in water, silt

The Nakhchivan reservoir was established in the channel of the Araz River bordering the Islamic Republic of Iran (1971-1972). It has an area of 145 km^2, a length of 40 km and a volume of 1.35 km^3 contane. It should be noted that 100% of its territory belongs to the Araz basin - polluted by Armenia, Araz waters are characterized by the mass development of phyto-bacterioplankton in the Nakhchivan reservoir throughout the year (Table 8).

Table 8

Formed in the photosynthesis of phytoplankton in the Nakhchivan reservoir quantity of incoming primary product by seasons (mg C/l - per day)

Station	Winter (II)		Spring (IV)		Summer (VIII)		Autumn (X)	
	t ° C	C ^{1}	t ° C	C	t ° C	C	t ° C	C
1	3.0	0.40	6.4	1.00	28.3	5.00	12.4	3.00
2	3.6	0.60	7.2	2.00	29.0	7.00	13.0	5.00
3	4.0	0.70	8.6	3.00	30.0	9.00	13.6	8.00
4	3.3	0.80	9.1	4.00	31.0	10.00	13.7	9.00
5	4.1	0.90	9.0	4.00	29.6	10.00	14.0	10.00
Medium	3.6	0.70	8.0	2.8	29.4	10.10	13.3	7.00
Increase compared to winter, times			2.2	5.0	8.2	14.4	3.7	10.7

Note: C^1 - indicator of organic matter containing 50% carbon;
2 - All results were statistically processed and $P \leq 0.044$.

It turns out that the Nakhchivan reservoir belongs to the hypereutrophic basin by trophic type.

Due to the abundance of organic matter in the Nakhchivan reservoir, the voltage in the oxygen regime is more clearly determined by the indicators of biodegradation (Table 9).

Table 9

Primary product and destructive in Nakhchivan reservoir quantitative change of organic substances by seasons (mg C / l per day) [1]

Station	Winter (II)		Spring (IV)		Summer (VIII)		Autumn (X)	
	PP [2]	DOM [3]	PP	DOM	PP	DOM	PP	DOM
1	0.4	5.00	1.00	9.30	5.70	14.50	3.0	10.40
2	0.60	5.00	2.00	8.10	7.00	15.50	5.00	9.80
3	0.70	4.00	3.00	7.40	9.00	14.60	8.00	9.60
4	0.81	3.60	4.00	5.30	10.00	11.60	9.00	8.80
5	0.90	2.00	4.00	6.30	10.00	11.90	10.00	7.40
Medium	0.7 0	4.00	2.8	7.40	10.0 0	14.40	7.50	3.20
Increase compared to winter, times			4.0	1.9	14.3	3.6	10.0	2.3

Note: 2. PP - primary product; 3 DOM-destructible organic matter; All results were statistically processed and $P \leq 0.048$.

It should be noted that organic matter mineralized in silt-soil in reservoirs belongs to difficult-to-oxidize substrates. However, 24.6 thousand tons of organic matter was destroyed in the silt-soil of the basin in 2016, which is twice as much as in the Mingachevir reservoir.

Table 10

In the sediments of the Nakhchivan reservoir in 2016 the amount of organic matter destroyed

Indicators	Winter	Spring	Summer	Autumn
Average daily indicator mg C / m^2	120	180	350	260
Destruction, C / ton	3132	3586	9134	6786
In	24638 tons / C			

Note: All results were statistically processed and $P \leq 0.047$.

5. Primary phytoplankton in Agstafachay reservoir product and total organic matter in water and destruction of lil-soil

The Agstafachay passes through 5-6 regions of Armenia and has become a means of discharging some kind of sewage into Azerbaijan. However, in the western regions of Azerbaijan, this river has played an important role in meeting the demand for water. Therefore, in 1970, a reservoir of the same name with a volume of 120 million m 3 and an area of 7.2 km 2 was created. Bacterio-phytoplankton grows in a reservoir rich in alloxton organic matter and biogenic elements, and therefore belongs to the type of hypereutrophic reservoirs since its inception (Table 11).

Table 11

Primary product of phytoplankton in Agstafachay reservoir, amount of organic matter destroyed in water (mg C/l) and silt-soil (mg C/m^2)

Station	Winter			Spring			Summer			Autumn		
	PP [1]	DW [2]	DS [3]	PP	DW	DS	PP	DW	DS	PP	DW	DS
1	0	0.9	150	1.6	4.3	300	3.3	3.6	440	1.1	6.3	330
2	0	1.1	210	2.0	4.6	340	4.2	7.2	480	2.2	4.4	310
3	0	1.3	250	2.4	5.2	360	5.8	7.6	510	3.1	3.3	300
4	0	1.4	240	3.0	5.3	380	6.7	8.1	630	3.6	3.0	410
5	0	1.5	300	3.3	5.5	400	7.4	8.8	710	7.4	3.3	500
Medium	0	1,2	226	2.5	5.0	356	5.5	8.0	552	2.7	6.6	410

Note: 1. PP-Primary product; 2. DW - destruction in water;
3. DS - destruction in soil

The amount of primary product synthesized in the Agstafachay reservoir during the year was 20,000, and the mass of destroyed organic matter was 60,400.

6. Yenikend reservoir

Yenikend reservoir was established in 2000 in the Kura tributary between Shamkir and Mingachevir. The total volume of the reservoir is 158 million m^3, 8 km long, 2.8 km wide and 2260 ha. There are no sources of direct anthropogenic impact on the Yenikend reservoir. However, bacterioplankton grows in the basin due to alloxton organic matter and biogenic elements entering from the upper bay. It was found that the transparency of water in the basin, temperature, oxygen content, the amount of primary product and the destruction of organic matter were evenly distributed. The initial yield of phytoplankton in Yenikend reservoir was 16.3 thousand tons per year, the amount of destroyed organic matter - 21.3 thousand tons.

7. Ashig-Bayramli reservoir

Ashig-Bayramli reservoir was established in 1956 in the territory of Ismayilli region, mainly due to the waters of Ayrichay and Akh-oxchay. Its area is 8 km^2 , its volume is 5.3 million m 3 and it is mainly intended for irrigation. *"However, water is also used for domestic purposes in coastal villages".* [13] Although the distance (along the stream) between the first source and the reservoir is short (15-16 km), the water in the upper bay is constantly polluted by the city of Ismayilli and settlements. Therefore, phytoplankton grows in the reservoir throughout the year.

Table 12

Primary product of phytoplankton in Ashig-Bayramli reservoir and indicators of destruction of total organic matter (mg O_2 / l)

Station	Winter		Spring		Summer		Autumn	
	PP [1]	D [2]	PP	D	PP	D	PP	D
1	0.1	0.4	0.6	1.4	2.3	4.4	0.5	2.9
2	0.2	0.6	0.9	3.1	3.0	4.8	0.9	3.1
3	0.3	0.8	1.4	4.2	3.1	3.9	1.8	3.6
4	0.4	0.9	2.3	4.1	3.6	4.4	2.8	4.2
5	0.4	1,2	3.2	4.3	3.7	4.8	4.1	3.6
Medium	0.3	1.0	1.8	3.4	3.3	4.5	2.0	3.5

The Ashig-Bayramli reservoir produces 20,000 tons of primary products a year and destroys 34,000 tons of organic matter. Therefore, it is estimated that 14,000 tons of alloxton-derived organic matter is discharged into the basin with wastewater.

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[13] Kasymov A.G. Oil and biological resources of the Caspian Sea. Baku, 2001, Print Studio, 336 p.

8. Yekakhana reservoir

The Yekakhana reservoir is in fact the "second" part of the Ashig-Bayramli reservoir, which is formed from the water flowing downstream. Both reservoirs were created off-channel, with “bring-in” water (from the main Akh-Oxchay to the Ayricha canal) (1963). The reservoir has an area of 3.7 km^2 and a volume of 21.2 million m^3.

It was found out that the water enriched with organic substances and biogenic elements in the Ashig-Bayramli reservoir is additionally polluted in the lower bay until it reaches the Yekakhana reservoir. Therefore, the initial production of phytoplankton in the Yekakhana reservoir is maintained at a high level throughout the year (Table 13).

Table 13

The primary product of phytoplankton in the single-cell reservoir and destruction of total organic matter (mg O_2/l)

Station	Winter		Write		Summer		Autumn	
	PP	D	PP	D	PP	D	PP	D
1	0.3	1.3	1.9	3.4	3.6	4.4	2.4	4.3
2	0.4	1.4	2.2	3.9	3.8	4.9	2.6	4.2
3	0.4	1.3	2.3	3.7	3.6	5.6	3.1	4.4
4	0.4	1.4	2.6	4.5	4.8	6.7	3.3	4.6
5	0.5	1.6	3.4	4.6	5.2	6.8	3.4	5.5
Medium	0.4	1.4	2.5	4.0	4.2	5.7	3.0	4.6

It became clear from the calculations that 16.3 thousand tons of primary products were synthesized in Yeka-khana reservoir during the year and the destroyed organic substances amounted to 24 thousand tons.

9. Arpachay reservoir

The Arpachay Reservoir was formed in the territory of Armenia and the Nakhchivan Autonomous Republic, in one of the left tributaries of the Araz River, in the riverbed of the same name, near the village of Gumushlu in the Sharur region (1977). Arpachay is pure and unadulterated, which is rare for modern times and does not change its natural stability! The temperature in the reservoir varies between

0.3-16ºC (average annual - 9ºC). Buogenic elements are analytically concentrated, and phytoplankton is very poorly developed. Therefore, the average annual amount of primary product and destruction did not exceed 0.7 and 0.9 mg O_2 / l, respectively. In the Nakhchivan reservoir, these figures are 8-12 times higher. Arpachay reservoir is fully suitable for oligatrophic basins due to its trophic type.

10. Shamkirchay reservoir

Shamkirchay reservoir was established in 2014. Although its modern reservoir has a capacity of 164.5 million m^3, its water reserves can be increased to 265 million m^3, depending on the coastal structure. Due to the mountainous climate and the lack of alloxton organic matter, phyto-bacterioplankton is poorly developed in the Shamkirchay reservoir. For this reason, the primary product of phytoplankton and the indicators of total organic matter are clearly small (Table 14). Therefore, the basin can be referred to as oligo-mesotrophic reservoirs.

Table 14

Primary product of phytoplankton in Shamkirchay reservoir and amount of destroyed organic matter (mg O_2 /l)

Station	Winter		Spring		Summer		Autumn	
	PP[1]	DW[2]	PP	DW	PP	DW	PP	DW
1	0	0.3	0.6	0.7	1.4	1,2	1.0	1.9
2	0	0.3	0.7	0.8	1.8	2.2	1,2	2.3
3	0	0.4	0.9	0.9	2.1	2.3	1.6	2.8
4	0	0.4	1,2	1.0	2.3	2.6	2.2	2.0
Medium	0	0.4	0.85	0.85	1.8	2.0	1.5	2.2

CHAPTER IV
MAIN WATER RESERVOIRS OF AZERBAIJAN MICROBIOLOGICAL REGIME

1. Microbiological regime of Mingachevir reservoir

"For the first time in Azerbaijan, microbiological research in water basins began in 1956 from the Mingachevir reservoir, and it became clear that the microbiological regime in the basin has not yet

stabilized (Figure 3)."[14]

This is due to the fact that the amount of alloxton organic matter, biogenic elements brought to the reservoir by river water is increasing year by year, and the mass development of bacterio-phytoplankton is intensifying. The persistence of organic pollution in the basin is evident from the quantity and quality of saprophytic bacteria. So, in summer, in 1958, the amount of saprophytic bacteria was 7 thousand/ml, in 1962, this indicator was 8.5; in 1970 – 10.2; in 1982 – 13.2; In 1994, it was 16.0, and finally, in 2015, it was 19 thousand/ml (Figure 3).

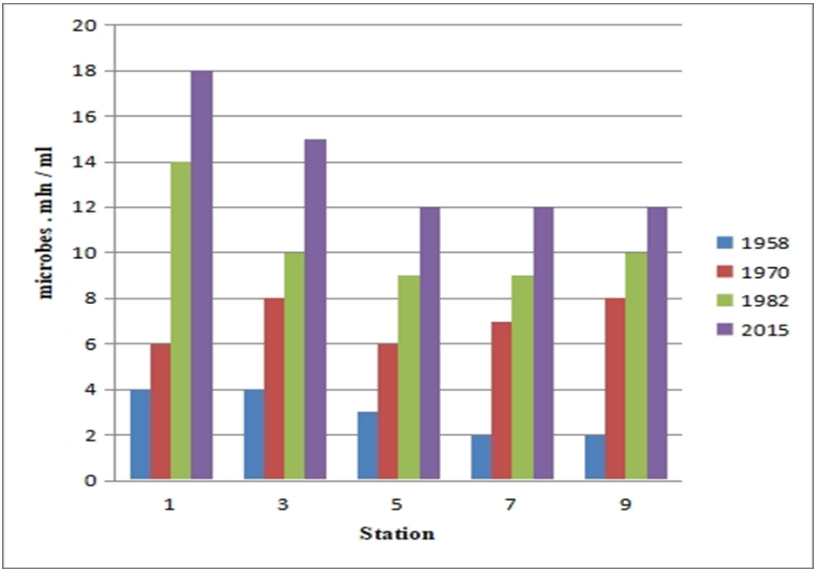

Fig. 3. Microbes in Mingachevir reservoir comparison of the average annual number

For the first time, migratory micromycetes in the basin have been studied in detail. It was found that 56 species of micromycetes are obtained from all biotopes of the basin and are actively involved in the elimination of plant residues, some oils and phenols.

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[14] Salmanov M.A. Microbiological characteristics of Mingechaursky reservoir. Tr. Institute of Biology of the USSR AN Reservoir, 1960, vol. 3 (6), p. 21-35

Table 15

Microbes in the silt of the Mingachevir reservoir change of total number by seasons (2015, mln/g)

Station	Depth, m	Properties of silt	Winter	Spring	Summer	Autumn
1	2.6	Weak fine sandy silt	4000	5800	7800	10,000
2	3.0	Gray silt	3600	5600	6900	8000
3	2.2	Dark gray silt	2600	6800	7100	9000
4	3.6	Weak brown sludge	2200	3100	5300	7000
5	18	Dark colored sludge	2100	2600	4100	6100
6	20	Brown silt	2000	2300	3000	4500
7	33	Light brown sludge	1800	2100	2000	2500
8	69	Weak pink soft slime	1600	1700	2000	2100
9	34	Dark brown colored sludge	1700	1800	2400	2600
10	12	Coffee-colored sludge	3200	3800	5400	6300
11	14	Detritus mixed mud	3600	41000	6300	7100
13	9	Plant mixed sludge	3400	4600	7100	8000
14	7	Detritus mixed sludge	3500	4800	7000	8400
Medium			2715	3720	5200	5670

Note: All results were statistically processed and $P \leq 0.040$.

The table clearly shows that the difference in the total number of microbes in the silt of the 7th, 8th and 9th stations during the year is on average 20-25%, while in the bottom sediments of other, shallower stations, the increase by 2-3 times per season was equal. This seems to be due to the fact that easily digestible organic matter is assimilated by bacterioplankton in the aquifers, and difficult-to-mineralize particles of substrates settle to the bottom. In addition, except in the winter months, the temperature at the bottom of the deep areas is always below 8-9ºC (statification, which occurs in spring, is maintained until autumn). *"As in the waters of the Mingachevir reservoir, the total number of microbes in the silt is 2-3 times higher than in the water of other eutrophic reservoirs ."*[15] The

[15] Salmanov M.A., Mamedova V.F. Modern microbiological condition of Shamkir reservoir. Matt. conf. to the 80th anniversary of M.Musaeva. Baku, 2001, p. 174-176.

predominance of microbes in water and bottom sediments is a factor in the overall trophism of reservoirs.

In the water and silt of the Mingachevir reservoir physiological group of bacteria

By physiological group, as the name implies, special microbial-bacterial groups are involved in the recovery, circulation and mineralization of various organic substances and chemical compounds. Indeed, the role of the physiological group microbiota in nature - in the metabolism of all three components of the biosphere - is great and irreplaceable. *"As far back as 180 years ago, Pasteur said that without the activity of the saprophytic-physiological group of bacteria, the Earth would have long been covered with corpses and humanity would have drowned in its own filth."*[16] It should be noted that in our research, more attention has been paid to saprophytic bacteria than to physiological group bacteria.

In 2015, the results of the number of saprophytic bacteria in the water in the Mingachevir reservoir by season (thousand /ml) and the ratio of spore forms to non-spore forms (%) are recorded in the table 16.

Table 16

Number of saprophytic bacteria in water in Mingachevir reservoir (thousand/ml) and ratio of spore forms to non-spore-forming strains (%)

Station	Winter		Write		Summer		Autumn	
	sapro-phyte	spor,%	sapro-phyte	spor,%	sapro-phyte	spor,%	sapro-phyte	spor,%
1	12.0	14.0	16.4	8.0	22.4	5.0	21.6	7.0
2	13.0	13.0	17.3	9.0	20.3	4.0	20.0	6.0
3	11.0	12.0	16.0	11.0	20.6	6.0	19.4	8.0
4	9.5	13.0	12.0	9.8	19.3	8.0	14.3	10.0
5	6.8	14	9.8	11.0	14.3	9.0	12.6	11.0
6	7.0	15	8.8	13.0	12.4	8.0	11.0	10.0
7	7.0	16.0	7.3	10.0	14.3	7.0	12.4	9.0

[16] Khatoonabadai A., Dehcheshmeh A.R.M. Oil pollution in the Caspian Sea coastal waters // İntem J. of Environment and pollution, 2006, v. 26, N 4, p. 347-363

Continuation of the Table 16

8	8.0	15.0	9.8	13.0	14.8	6.0	12.6	7.0
9	8.0	18.0	10.4	15.0	16.3	5.0	13.3	6.0
10	10.0	17.0	14.8	14.0	18.4	4.0	15.8	8.0
11	12.0	16.0	15.3	13.0	20.3	6.0	17.4	8.0
12	13.0	14.0	16.2	10.0	22.4	5.0	19.6	7.0
13	14.0	12.0	18.4	10.0	21.6	4.0	18.7	6.0
14	12.0	14.0	17.3	11.0	20.4	4.4	17.4	7.0
Medium	11.0	15.0	14.0	11.5	18.4	9.8	18.0	8.0

Note: All results were statistically processed and $P \leq 0.046$.

It is clear from the table that the amount of saprophytic bacteria in the water varies on average around 11-18 thousand/ml per year. The difference between the winter minimum and the summer maximum is only 40%, which is a very small figure. It is known that the temperature of the environment-biotope plays an important role in the life, physiological and biochemical activity of living organisms, including microbial cells. *"Furthermore, experiments have shown that mineralization slows down at temperatures below 7-9 °C."*[17]

Table 17

Aerobic and anaerobic in water in Mingachevir reservoir amount of cellulose-degrading bacteria (in 1 ml)

Station	Winter		Write		Summer		Autumn	
	aerobic	anaerobic	aerobic	anaerobic	aerobic	anaerobic	aerobic	anaerobic
1	10	10	2.00	10	310	100	400	100
2	10	10	300	100	400	100	500	100
3	10	10	300	100	400	100	600	100
4	10	10	100	100	400	100	400	100
5	10	10	100	200	100	200	400	200
7	10	10	100	100	100	200	300	200
8	100	10	200	200	100	200	500	300
10	100	10	300	100	300	100	400	100
11	100	10	300	100	400	100	700	100
12	100	10	300	100	200	100	800	100
Medium	46	10	220	111	270	130	500	140

Note: All results were statistically processed and $P \leq 0.048$.

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[17] Margolina G.L. Microbiological processes of deseses of destruction in freshwater reservoirs. Nauka, 1989, p.119.

It is shown from the table that the aerobic forms involved in the decomposition of plant residues in the Mingachevir reservoir are 2.7 times more than the cellulose-absorbing bacteria of the anaerobic respiratory type.

The amount of aerobic cellulose-degrading bacteria in the silt of the Mingachevir reservoir is on average 2-3 times higher than that of anaerobic cellulose-absorbing bacteria.

Table 18

Cellulose debris in the silt of the Mingachevir reservoir amount of aerobic and anaerobic bacteria (min/g)

Station	Winter		Spring		Summer		Autumn	
	aerobic	anaerobic	aerobic	anaerobic	aerobic	anaerobic	aerobic	anaerobic
1	0.3	0.2	1.0	0.6	3.0	0.5	3.0	0.3
2	0.3	0.2	1.0	0.5	3.0	0.4	3.0	0.2
3	0.2	0.1	1.0	0.3	2.0	1.0	2.0	1.0
4	0.2	0.1	1.0	0.3	2.0	1.0	2.0	1.0
5	0.2	0.1	1.0	0.5	2.0	1.0	1.0	1.0
7	0.3	0.1	1.0	0.4	1.0	1.0	2.0	1.0
8	0.2	0.2	1.0	0.3	1.0	0.6	1.0	1.0
10	1.0	0.1	1.0	1.0	4.0	1.0	3.0	1.0
11	1.0	0.1	1.0	1.0	5.0	1.0	4.0	1.0
12	1.0	0.1	1.0	1.0	6.0	1.0	4.0	1.0

Note: All results were statistically processed and $P \leq 0.046$.

It is clear from the table that the amount of cellulose-degrading bacteria is not evenly distributed over the area of the results of other analyses. It is interesting to note that the widespread distribution of a special group of cellulose-decomposing bacteria in biotopes rich in common, dissolved organic matter can be assessed as their active participation in biodegradation processes.

2. Microbiological regime of Varvara reservoir

Due to the formation of different biotopes in the right bank and left bank waters of the Varvara reservoir, the distribution and quantity of microbes are not similar.

Table 19

Total seasons of microbes in Varvara Reservoir in water (mln/ml) and silt-soil (billion / g) by seasons (2015)

Station	Winter		Spring		Summer		Autumn	
	water	silt-soil	water	silt-soi	water	silt-soi	water	silt-soi
Top	3.0	3.2	4.3	4.1	6.9	4.1	4.3	4.8
Medium	3.6	3.0	4.8	5.6	8.3	9.2	7.4	6.0
Down	4.4	5.0	7.6	9.2	10.4	10.3	11.4	10.2
Left bank	9.4	8.7	12.4	14.4	16.4	14.6	12.6	12.3
Medium	4.0	4.0	7.2	8.7	10.5	9.7	9.0	8.2

The amount of saprophytic bacteria in the reservoirs of Mingachevir city and neighboring settlements is also high: the average annual rate in water is 31 thousand/ml, and in silt - 5.7 million/g, which is evidence of polysaccharide water bodies.

3. Microbiological regime of Shamkir reservoir

The number of microbes in the Shamkir reservoir, which is the first to receive polluted river water outside the country, is growing every year. Comparing the results of epizootic research conducted in the 90s of the last century with the results obtained in 2015, it is clear that the dynamics of microbiota development in the Shamkir reservoir has not yet stabilized.

Table 20

Common microbes in the water in the Shamkir reservoir change in the number of years in the water by years and seasons (mln/ml)

Station	Winter		Spring		Summer		Autumn	
	1994	2015	1994	2015	1994	2015	1994	2015
1	8.2	10.4	12.2	16.3	19.8	26.5	17.8	24.0
3	8.0	11.3	11.6	14.7	16.2	23.2	16.0	23.0
8	4.0	7.8	7.0	9.8	11.3	13.4	9.8	13.6
Medium	6.6	9.8	10.0	13.6	15.6	21.0	14.5	20.0

It is clear from the table that the number of microbes has increased 2-3 times in the last 20 years.

The average annual amount of saprophytic bacteria in water and silt does not exceed 10 thousand/l and 9 million/g, respectively, and the spore forms do not exceed 15-10%, which indicates that organic pollution in the Shamkir reservoir continues throughout the year and increases the cost.

Water and silt in Shamkir reservoir physiological group of bacteria

The results of seasonal surveys completed in 2015 showed that the number of saprophytic bacteria in the Shamkir reservoir is not the same across areas. It is clear from the table that the number of saprophytic bacteria in the waters of stations 1, 2 and 3 is on average twice as much throughout the year. The same situation was noted in the total number of microbes in the water. Thus, it is once again clear that the role of alloxton organic substances brought through the Kura River in the development and generation of microbiota in the Shamkir reservoir is great.

Table 21

Saprophyte in the upper layer of water by seasons in Shamkir reservoir number of bacteria (thousand/ml) and spore-forming forms (%)

Station	Winter		Write		Summer		Autumn	
	sapro-phyte	spor,%	sapro-phyte	spor,%	sapro-phyte	spor,%	sapro-phyte	spor,%
1	12.6	24.3	16.6	18.4	24.3	6.4	21.3	9.2
2	10.6	19.6	14.6	11.7	19.8	7.8	17.6	7.0
3	9.3	15.4	12.4	10.0	16.3	7.7	16.0	8.2
4	6.4	11.6	8.3	7.3	10.2	6.0	8.4	6.4
5	4.6	9.0	7.3	6.7	8.2	5.3	7.6	6.3
6	6.3	10.3	8.8	6.8	9.8	5.2	8.2	6.7
7	5.0	12.4	7.6	6.4	8.2	6.4	7.9	7.1
8	3.0	10.4	8.7	6.6	9.7	5.7	8.8	6.9
9	4.0	12.3	7.3	6.8	10.4	8.7	9.4	10.1
Medium	6.9	14.0	9.5	8.0	13.0	6.5	12.0	7.7

Note: All results were statistically processed and $P \leq 0.045$.

Also, the ratio of saprophytic bacteria to spore-forming forms proves that the organic matter in the Shamkir reservoir is easily assimilated and rich in proteins. The table shows that the number of sports-forming forms in winter is 14%, which is not high.

Table 22

Number of aerobic and anaerobic cellulose-breaking bacteria in the silt-soil of Shamkir reservoir in 2015 (min/ml)

Station	Aerobic				Anaerobic			
	winter	spring	summer	autumn	winter	spring	summer	autumn
1	10.0	10.0	100.0	100.0	10.0	10.0	100.0	100.0
2	10.0	100.0	100.0	100.0	10.0	100.0	100.0	100.0
3	10.0	100.0	100.0	100.0	100.0	10.0	100.0	100.0
4	10.0	100.0	100.0	100.0	10.0	100.0	100.0	100.0
5	10.0	100.0	100.0	100.0	10.0	100.0	100.0	100.0
6	10.0	100.0	100.0	1000.0	100.0	100.0	1000.0	1000.0
7	10.0	100.0	1000.0	1000.0	100.0	1000.0	1000.0	1000.0
8	10.0	100.0	1000.0	1000.0	100.0	1000.0	1000.0	1000.0
9	10.0	100.0	100.0	1000.0	100.0	1000.0	1000.0	1000.0

Note: All results were statistically processed and $P \leq 0.044$.

The table shows that the number of aerobic cellulose-decomposing bacteria, although the "saturation" of water with oxygen in the silt is low, reaches one million grams in deep areas. The average annual amount of aerobic bacteria is at the level of anaerobic bacteria. Therefore, it can be acknowledged that bacterial groups of both respiratory groups are actively involved in the decomposition of plant substrates in the bottom sediments of the Shamkir reservoir. Typically, in the laboratory, during the incubation period, the decomposition time of the substrate used as a substitute for cellulose was both intensive and 6-7 days shorter in aerobic experiments. Therefore, it can be assumed that aerobic bacteria are more active in the mineralization of cellulose in the Shamkir reservoir.

Taxa of the genus Aerobic Azotobacter, which participate in the nitrogen cycle and freely fix atmospheric nitrogen, are almost widespread in the upper layer of water in the Shamkir reservoir.

Table 23

In the upper layer of water in the Shamkir reservoir seasonal quantities of Azotobacter in 2015

Station	Winter	Spring	Summer	Autumn
1	200 ± 9.3	320 ± 14	680 ± 32	420 ± 20
2	160 ± 7.4	210 ± 9	590 ± 28	330 ± 15
3	10 ± 0.4	68 ± 3	330 ± 15	260 ± 12
4	10 ± 0.4	70 ± 3	230 ± 10	195 ± 9
5	40 ± 0.9	86 ± 4	170 ± 8	160 ± 7
6	100 ± 3.6	160 ± 7	210 ± 10	180 ± 8
7	60 ± 2.3	110 ± 5	230 ± 11	196 ± 9
8	90 ± 3.6	130 ± 6	320 ± 15	217 ± 10
9	100 ± 4.5	145 ± 7	360 ± 16	233 ± 11
Medium	83	144	347	244

It is clear from the table that Azotobacter is obtained from stations covering the entire area of the Shamkir reservoir. Interestingly, the center of the reservoir, Azotobacter in the waters near the dam, is 90-360 / ml per year. Azotobacter, which acts in symbiotic contact with higher aquatic plants, is 250-350 / ml in open water, which is not uncommon, but it is a rare fact. Typically, the prevalence of Azotobacter taxa in summer and autumn coincides with the mass development of phytoplankton. Therefore, it is assumed that Azotobacter acts in the context of phytoplankton and plays a positive role in the enrichment of the environment with nitrate-nitrite. Interestingly, the water in the reservoir is recorded in the bottom layers, in all areas and seasons. Interestingly, the highest rate in the reservoir is recorded in water samples taken from the deepest stations.

Table 24

Clyostridium in the bottom layer of water in the Shamkir reservoir quantity of pasteurianum by seasons (2015)

Station	Winter	Spring	Summer	Autumn
1	60 ± 2.5	120 ± 5.4	500 ± 22.6	600 ± 28.5
2	50 ± 2.4	110 ± 5.2	600 ± 27.5	400 ± 16.6
3	60 ± 2.6	130 ± 5.5	300 ± 13.6	300 ± 13.6
4	80 ± 3.4	200 ± 8.6	500 ± 23.6	600 ± 28.4
5	100 ± 4.5	300 ± 14.3	700 ± 33.6	900 ± 43.6
6	200 ± 9.4	400 ± 18.6	900 ± 43.6	1000 ± 46.6
7	300 ± 12.6	500 ± 22.4	1200 ± 54.6	900 ± 42.6
8	800 ± 34.4	900 ± 42.5	1600 ± 66.7	800 ± 36.5
9	500 ± 22.4	700 ± 32.2	1200 ± 54.3	900 ± 42.5
Medium	234	373	833	722

Denitrating bacteria, which occupy a special position in the nitrogen cycle, in contrast to the nitrogen-fixing microbiota, convert nitrate-nitrite compounds in the hydroecosystem into free-molecular nitrogen and cause biogenic loss. *"In other words, anaerobic denitrating bacteria reduce fertility and trophism by restoring mineral nitrogen to free nitrogen in the soil and water, and contribute to a dangerous situation such as anaerobiosis ."*[18]

In the Shamkir reservoir, denitrating bacteria are not widespread in the water, unlike those that fix nitrogen.

4. Microbiological regime of Nakhchivan reservoir

Even in winter (temperature 3-4ºC), the total number of microbiota in the Nakhchivan reservoir, which receives water enriched with alloxton organic substances directly in Armenia

[18] Abe D.S., Rosha O., Matsumura-Tundusi. Nitrification and denitrification in a series of reservoirs in the tiete river. Congress Limnology, Melbourne, 2001, p. 877-880.

throughout the year, reaches 14-15 million/ml, which is 4 times higher than in summer in many eutrophic reservoirs 5 times higher. The number of saprophytic bacteria in the basin is high throughout the year in water and silt. It is typical that in both environments (water, soil) spore forms did not exceed 8-12%. The Nakhchivan reservoir is the most enriched in alloxton organic matter.

For example, the average annual number of saprophytic bacteria in the Shamkir reservoir is 7 thousand/ml, in the Agstafachay reservoir – 6 thousand/ml, while in the Nakhchivan reservoir this figure is 25 thousand/ml.

Table 25

Saprophytic bacteria in the Nakhchivan reservoir amount in water (min/ml) and silt-soil (mln/g)

Station	Winter		Spring		Summer		Autumn	
	water	soil	water	soil	water	soil	water	soil
1	21.0	2.4	30.0	3.4	38.0	5.3	23.0	5.5
2	19.0	2.0	28.0	4.2	39.0	6.3	24.0	6.2
3	18.0	2.4	28.0	3.6	39.0	4.2	18.0	5.7
4	16.0	3.2	27.0	4.4	41.0	4.0	19.0	4.8
5	15.0	3.3	26.0	4.6	43.0	4.1	21.0	5.1
Medium	18.0	2.7	24.4	4.0	40.6	4.8	16.6	5.5

The table shows that even in winter, saprophytic bacteria in water and silt are on average 18 thousand / ml and 2.7 million / g. *"For comparison, the amount of saprophytes in the Nakhchivan reservoir in the winter months is higher than in the summer in the chain reservoirs created in the Volga and Dnieper rivers"*[19].

[19] Georgievsky V.D. Changes in the flow of water in Russia and the water balance of the Caspian Sea under the influence of economic activity and global warming . Author's abstract. diss. on the search. scientist. degrees doctor Geogr/Science,Spb.2005,40 p.

Table 26

Number of denitrifying, sulfating and anaerobic cellulose-decomposing bacteria in silt-soil in Nakhchivan reservoir (spring, summer and autumn) (min/g)

Station	Write			Summer			Autumn		
	Denit.[1]	Sulfate.[2]	ASP.[3]	Denit.	Sulfate.	ASP.	Denit.	Sulfate.	ASP.
1	25.0	6.6	2.4	100.0	8.0	4.8	60.0	7.6	5.3
2	23.0	8.3	3.1	100.0	9.2	5.7	70.0	11.0	6.2
3	21.0	9.8	2.9	100.0	11.3	9.8	55.0	13.2	7.9
4	19.0	14.2	4.4	100.0	16.8	11.3	60.0	18.0	8.9
5	14.0	16.3	4.6	100.0	20.0	12.0	50.0	32.0	11.3

Note: 1 - denitrating; 2 - sulfating agent; 3 - ASP anaerobic cellulose breaker;
4 - All results were statistically processed and $P \leq 0.044$.

It is clear from the table that anaerobic bacteria are widespread in the bottom sediments of the Nakhchivan reservoir and their numbers are very high. The fact that denitrating bacteria are
60-100 t thousand/g throughout the year is due to the presence of protein-rich organic matter in the water. It has been proved that the main source of protein-rich organic substances in river waters is household, food and livestock wastes. The environmental threat to the ecosystem in the Nakhchivan reservoir is sulfating bacteria. This is because the life activity of the microbiota belonging to this group continues by producing hydrogen sulfide, which is considered a poison for the entire living world. Anthropogenic eutrophication occurs in water bodies that are constantly polluted and exposed to anthropogenic influences, oxygen consumption in easily mineralized water, silt and soil increases, hypoxia occurs and mass vegetation of anaerobic bacteria continues, and finally anaerobic processes lead to mass slaughter. becomes useless.

It is clear from the table that although the water temperature is less than 9 times lower in winter than in summer, the difference in the number of microbes is only 25%. This means that although the water balance in the Araz River changes during the seasons, the volume of sewage discharged into the river remains stable throughout the year.

Table 27

Coli-enterobacteriaceae (KEB) in Nakhchivan reservoir amount of bacteria belonging to the genus (thousand/ml)

Station	Winter		Write		Summer		Autumn	
	t °C	KEB [1]	t °C	KEB	t °C	KEB	t °C	KEB
1	3.0	13.0	6.4	12.2	28.3	14.3	12.4	16.4
2	3.6	10.3	7.2	12.0	29.0	13.4	13.0	13.3
3	4.0	9.8	8.6	11.6	30.0	12.0	13.6	11.4
4	3.3	8.6	9.1	10.2	31.0	11.4	13.7	10.8
5	4.1	7.4	9.0	10.0	29.6	10.6	14.0	10.3
Medium	3.6	9.8	8.0	11.2	29.5	12.4	13.3	10.4

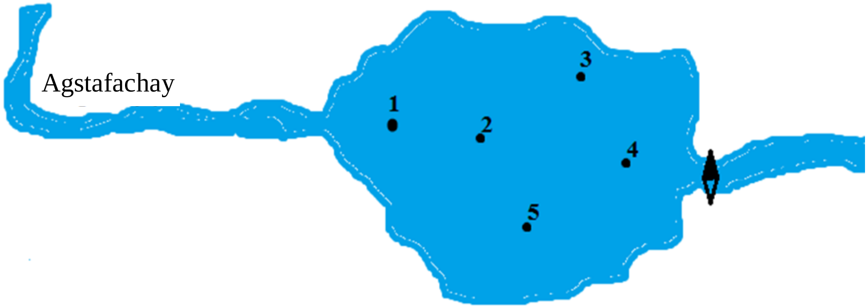
Note: 1. KEB - coli-enterobacteriaceae;
2. All results were statistically processed and $P \leq 0.045$.

The fact that repeated fluctuations in temperature do not have a significant negative impact on coli-enterobacterial cells is explained by the fact that the sources of sewage are located near the Araz-Nakhchivan reservoir and continuously pollute the water.

5. Microbiological regime of Agstafachay reservoir

The Agstafachay Reservoir, which receives highly polluted water in Armenia, maintains high levels of alloxton-derived organic matter throughout the year, and there is hypoxia in the basin due to the intensive use of oxygen in the sediments. Therefore, anaerobic bacteria in relatively deep stations are 8-10 times more than aerobic forms. Intensive development of microbiota in the water in the reservoir is directly proportional to the consumption of oxygen. Therefore, there is tension in the sludge-soil in the oxygen regime.

Our research was completed in 2013 by season. Water and silt samples were obtained from 5 stations covering the entire area of the reservoir.



Cartoon-map of Agstafachay reservoir.
Figures are the areas where samples are collected.

Table 28

In the Agstafachay reservoir in water (thousand/ml), in silt (billion/g) total number of microbes and saprophytic bacteria amount in water (thousand/ml) and silt-soil (mln / g)

Type of analysis	Station	Winter		Spring		Summer		Autumn	
		water	silt	water	silt	water	silt	water	silt
The total number of microbes	1	1.6	1.4	3.4	2.2	6.8	3.2	4.6	3.2
	2	1.3	2.0	4.2	2.9	7.5	4.1	5.2	4.4
	3	0.9	1.9	3.6	3.2	8.8	4.6	4.9	4.7
	4	1.0	2.1	4.4	3.6	9.3	4.2	5.3	4.9
	5	1.3	2.2	5.2	4.1	10.4	4.6	5.5	4.0
	Medium	1,2	1.9	4.2	3.2	8.4	4.0	5.0	4.2
Saprophytic bacteria	1	2, 0	3.1	8.2	4.4	9.6	3, 6	4.4	2.6
	2	1.8	3.4	7.4	5.2	8.7	3.9	5.2	3.7
	3	2.0	4.3	6.3	4.6	8.8	4.1	5.1	3.3
	4	2.3	4.0	6.0	5.1	9.8	3.7	5.5	4.3
	5	2.6	4.4	5.9	5.0	10.4	4.6	5.7	4.8
	Medium	1,2	3.8	6.8	4.7	9.8	4.0	5.2	3.7

Note: All results were statistically processed and $P \leq 0.046$.

The table shows that the total number of microbes in the Agstafachay reservoir reaches 9-10 million / ml in summer and 4.6 billion / ha in silt. The amount of saprophytic bacteria in winter is on average 1.2 thousand / ml, and in summer - 9.8 thousand / ml. Very interesting indicators are recorded in the silt. The table shows that while the amount of saprophytic bacteria in winter, when the water temperature is freezing, is 3.8 million / g, in autumn or early spring, when the water temperature is 4-5 times higher, the number of saprophytes is 3.7, respectively. -4.7 million / ha. As can be seen, the winter rate is only 20-30% lower than the spring-autumn rate. At the same time, the total amount of microbes in the water in winter was 3-4 times smaller than the results obtained in spring and autumn. Thus, it turns out that the bottom sediments of the Agstafachay reservoir are rich in easily digestible organic matter components. Due to the variable level regime in the basin, the depth is not kept constant and the organic matter precipitates in the sludge without complete elimination in the aquifers. It is also evidenced by the abundance of easily digestible, or rather protein, household organic matter in the silt, and the high percentage of spore-free formation of saprophytic bacteria.

6. Microbiological regime of Yenikend reservoir

The dynamics of bacterial growth in the Yenikend reservoir differs little from the indicators recorded in the Shamkir reservoir. The total number of microbiota (average annual) is 5.2 million / ml in water and 2 billion / g in silt. The amount of saprophytic bacteria is 30 min / ml and 2.3 million / ha, respectively.

Table 29

Number of microbes in Yenikend reservoir (mln/ml) and silt-soul (million / g) seasonal variation

Precinct	in water				silt-soil			
	II	IV	VIII	X	II	IV	VIII	X
Top	3.6	6.4	7.3	6.6	0.60	1.60	2.20	2.00
Center	3.2	5.6	7.0	6.4	0.74	2 , 00	2.16	1.66
Dam	3.3	4.9	7.3	6.2	0.66	1.24	2.46	2.10

Although the total number of microbes in the Yenikend reservoir is similar in all seasons of the year, it varies from time to time, on average, by 50%. The equal distribution of microbiota in the water in the upper, central and dam areas of the reservoir shows that the source of energy required for the physiological activity of microbial cells in the basin, there are no differences in the effects of physical and chemical factors.

Quantitative and qualitative indicators of saprophytic bacteria, which are more sensitive to external factors, especially to organic substances, which are considered a source of energy, and are vegetatively accepted, are considered mobile in comparison with the total number of microbiota in Yenikend reservoir.

Table 30

Saprophytic bacteria in the Yenikend reservoir change in water (thousand/ ml) and silt-soil (mln / g)

Precinct	II		IV		VIII		X	
	water	soil	water	soil	water	soil	water	soil
Top	0.68	0.64	55.0	2.10	60.0	2.60	18.0	3.20
Medium	0.52	0.87	49.0	3.20	68.0	2.80	15.0	2.60
Dam	0.33	0.98	48.0	2.10	53.0	3.10	13.0	2.40
Medium	0.51	0.90	51.0	3.10	60.0	2.80	15.0	2.70

The table shows that saprophytic bacteria, which form the basis of heterotrophic bacteria in the active-vegetative state, vary significantly depending on the season and climatic factors of the year. If in those periods the difference between the minimum and maximum values in the total amount of microbiota was 50-60%, in saprophytic bacteria this difference was more than 10 times. In addition, there is a clear difference in the seasons. The average annual amount of saprophytic bacteria in water and silt is 32 thousand / ml and 2.5 million /g, respectively. At the same time, the number of saprophytic bacteria in the silt-soil is uniformly distributed, both from time to time and spatially. This shows that the amount of organic matter and biogenic elements, which are considered a source of energy in the silt, does not change dramatically.

In conclusion, it can be acknowledged that the Yenikend reservoir is free of active and direct anthropogenic sources, and the general biological processes in the basin occur against the background of substances entering from the Shamkir reservoir. It should also be noted that although the Yenikend reservoir has a "daily" regime, it is very important to protect it along the coast from a sanitary point of view, because the reliability of the ecological situation in a giant reservoir such as the Mingachevir reservoir depends on it.

7. Microbiological regime of Ashig-Bayramli reservoir

The development of microbes, population dynamics, biochemical activity and other characteristics of the reservoir created by the water flowing from the Ak-Oxchay to the Ayrichay channel through a special channel depend on alloxton substances brought from the upper bay. It was found that the number of microbes in the water area of the reservoir, which enters the river, is 2-3 times higher than in the central part. Therefore, it is assumed that the water in the upper bay is constantly polluted.

However, it should be noted that in Azerbaijan, where water is scarce, especially in local areas, various types of hydraulic structures, irrigation canals and, finally, reservoirs are used to develop agriculture and provide other areas with fresh water, reservoirs have been established and this work is still on going.

Table 31

Cellulose decomposer free in Agstafachay reservoir nitrogen-fixing çdenitrifying $\left(\frac{aerobic}{anaerobic}\right)$ and sulfating amount $\left(\frac{aerobic}{anaerobic}\right)$ of bacteria in 1 ml water and 1 g of sludge-soil

Type of analysis	Station	Winter		Spring		Summer		Autumn	
		water	silt	water	silt	water	silt	water	silt
Cellulose breaker	1	$\frac{10}{0}$	$\frac{10}{10}$	$\frac{100}{10}$	$\frac{100}{1000}$	$\frac{100}{100}$	$\frac{100}{1000}$	$\frac{10}{10}$	$\frac{10}{10}$
	2	$\frac{10}{0}$	$\frac{10}{100}$	$\frac{100}{100}$	$\frac{100}{1000}$	$\frac{10}{100}$	$\frac{100}{1000}$	$\frac{10}{100}$	$\frac{10}{10}$

Continuation of the Table 31

	3	$\frac{10}{0}$	$\frac{10}{100}$	$\frac{100}{100}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{100}$
	4	$\frac{10}{100}$	$\frac{10}{1000}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{1000}$	$\frac{100}{100}$	$\frac{100}{100}$
Nitrogen fixation	1	$\frac{0}{0}$	$\frac{10}{0}$	$\frac{10}{0}$	$\frac{44}{12}$	$\frac{66}{100}$	$\frac{44}{110}$	$\frac{10}{10}$	–
	2	$\frac{10}{0}$	$\frac{26}{14}$	$\frac{36}{21}$	$\frac{11}{29}$	$\frac{74}{250}$	$\frac{37}{210}$	$\frac{10}{160}$	$\frac{10}{0}$
	3	$\frac{10}{0}$	$\frac{33}{13}$	$\frac{24}{9}$	$\frac{31}{19}$	$\frac{106}{330}$	$\frac{20}{260}$	$\frac{26}{210}$	$\frac{10}{100}$
	4	$\frac{10}{0}$	$\frac{24}{11}$	$\frac{38}{46}$	$\frac{24}{70}$	$\frac{78}{240}$	$\frac{11}{380}$	$\frac{9}{440}$	$\frac{30}{210}$
	5	$\frac{10}{0}$	$\frac{16}{14}$	$\frac{21}{60}$	$\frac{16}{160}$	$\frac{64}{280}$	$\frac{9}{760}$	$\frac{11}{860}$	$\frac{8}{660}$
Denitrate	1	0	0	10	100	100	1000	100	100
	2	0	0	10	100	1000	1000	100	1000
	3	0	100	100	100	1000	1000	1000	1000
	4	0	100	100	100	1000	1000	1000	1000
	5	0	1000	1000	100	100	1000	1000	1000
Sulfate-laden	1	0	0	0	19	0	29	0	34
	2	0	10	0	26	14	39	9	96
	3	0	13	3	140	20	140	36	16 0
	4	0	9	7	210	11	240	11	210
	5	0	24	9	190	14	310	9	330

Note: All results were statistically processed and P ≤ 0.044.

Reservoirs are being created in the regions to meet the demand for water, local, small rivers. For this purpose, Ashig-Bayramli and Yekakhana reservoirs belonging to Ismayilli and Goychay districts, close to each other and in the course of the former river (drying) were created. It is noteworthy that both reservoirs were not created by building a dam in the riverbed. Here, water from Ayrichay is directed to the natural flow of the Davabatan river, moreover, water is discharged here from Akh-oxchay through a special channel and collected in the Ashig-Bayramli reservoir in the Ismayilli region. The water is transferred to the lower bay by a special sluice-water supply device and directed to the canal, to the Yekakhana reservoir located in the territory of the Goychay region (neighboring). As can be seen, both interconnected reservoirs belong to offshore reservoirs, and the volume of water used from them is precisely controlled. It is interesting that the role of these small reservoirs in the life of villages located in an area of 30 km from the upper shore of the Ashig-Bayramli reservoir to the lower shore of the Yekekhana reservoir (water distribution sluices) is very large. Therefore, accurate microbiological and sanitary-hydrobiological studies have been conducted in these basins.

8. Microbiological regime of Yekekhana water reservoir

In fact, the water flowing into the Yekakhana reservoir, which is a continuation of the Ashig-Bayramli reservoir, is polluted in the distance between the two basins. Thus, if the number of microbes in the water leaving the Ashig-Bayramli reservoir reaches 2.3-3.0 million / ml, in the water entering the Yekakhana reservoir - 5-6 million / ml. It was found that the average annual rate of microbes in the part of the reservoir near the dam is 1.5-2 times higher. Although the basin is not deep, hypoxia (mainly in summer) occurs in the silt-soil and environmental stress is observed in the oxygen regime.

Table 32

The primary product of phytoplankton in the single-cell reservoir and indicators of destruction of total organic matter (mg O_2/l)

Station	Winter		Spring		Summer		Autumn	
	PP	D	PP	D	PP	D	PP	D
1	0.3	1.3	1.9	3.2	3.3	4.0	2.4	3.9
2	0.4	1.4	2.2	3.6	4.1	4.6	2.6	3.7
3	0.4	1.3	2.3	3.4	4.0	5.3	3.1	4.2
4	0.5	1.4	2.6	4.2	4.6	5.8	3.3	4.4
5	0.4	1.6	3.4	4.4	5.2	6.1	4.4	4.9
Medium	0.4	1.40	2.4	3.8	4.2	5.2	3.2	4.2

Note: All results were statistically processed and $P \leq 0.045$.

It is clear from the table that the average annual yield (phytoplankton) in the Yekekhana reservoir is 2.5 mg O_2/l, and destruction - 3.65 mg O_2/l. Both of these indicators are twice higher than those identified in the Ashig-Bayramli reservoir. However, although the total yield is relatively high, the elimination of total organic matter in the YekaKhana reservoir is weak. If the destruction in the Ashig-Bayramli reservoir is 1.6-1.7 times higher than the productivity, in the Yekekhana reservoir this figure is 1.4. Therefore, it can be assumed that due to the shallow depth of the YekaKhana reservoir, organic substances of alloxton and autochthonous origin, phytoplankton mass, which completes the growing season, and even easily assimilated components accumulate in the silt without complete mineralization.

9. Microbiological regime of Shamkirchay reservoir

The number of saprophytic bacteria in the Shamkirchay reservoir, where water is not polluted by organic substances of allochthonous origin,is collected in the upper bief,during the year is 0.3 (winter)-1.7 thousand/ml(summer) and in bottom sediments-it is equal to 0.4-1.2 mln/g. Interestingly, in both environments, 40-45% of the culture consists of spores. The physiological group of bacteria is very poorly developed in the basin. Therefore, the reservoir is clean and is considered a source for domestic use.

Table 33

Changes in hydrochemical parameters (mg/l) in Shamkirchay reservoir in summer

Station	Nitrite	Nitrate	Ammonium	Phosphate	Phenol	Cuprum	Zinc
1	00.01	33.00	0	00	00.04	00	00
2	00.02	22.0	0	00	00.03	00	00
3	00.02	11.6	0	00	00.02	00	00
4	00.01	11.0	0	00	00.02	00	00
5 (reservoir outlet)	00.06	55.0	0.3	00.04	00.04	00	00
6 (Seyfali village)	00.03	66.0	0.4	00.1	00.06	00	00
7 (Plane)	00.09	77.0	0.6	00.3	00.08	00	00

Note: All results were statistically processed and $P \leq 0.045$.

Alloxton and autochthonous organic substances can be considered as the main factor in changing the physical and chemical stability of the Shamkirchay reservoir. From the results of hydrochemical studies completed in the Shamkirchay reservoir, it was found that nitrites (NO_2), nitrates (NO_3) and phosphates (PO_4) from biogenic elements in the winter months were 0.03 (on average); 8.0 and 0.02 mg/l, while ammonium is not determined. In the spring, nitrates from these elements are reduced by 2 times. In summer, phosphates and ammonium are not determined, and the amount of nitrites is reduced to the analytical concentration, and nitrates are reduced by 2-3 times compared to spring.

Interestingly, in summer, the amount of nitrates in the water leaving the reservoir is 2-3 times higher. In addition to phosphates, ammonium is also found in the lower biep. The concentration of phenols increases 2-3 times in summer. Copper and zinc compounds have not been identified throughout the year.

Table 34

Seasonal change of primary phytoplankton product and total amount of destroyed organic matter (mg O_2/l) in Shamkirchay reservoir

Sample station-station	Winter		Spring		Summer		Autumn	
	PP [1]	DW [2]	PP	DW	DD	DW	DD	DW
1	0	0.3	0.6	0.7	1.4	1,2	1.0	1.9
2	0	0.3	0.7	0.8	1.8	2.2	1,2	2.3
3	0	0.4	0.9	0.9	2.1	2.3	1.6	2.8
4	0	0.4	1,2	1.0	2.3	2.6	2.2	2.0
Medium	0	0.4	0.85	0.85	1.8	2.0	1.5	2.2
5	0	0.2	0	0.4	0	1.3	0	0.9
6	0	0.6	0	1.3	0	3.8	0	3.6
7	0	0.9	0	2.4	0	7.4	0	7.0
Medium	0	0.4	0	1.3	0	4.0	0	3.8

Note: All results were statistically processed and $P \leq 0.044$.

It was found that the primary organic matter synthesized by phytoplankton in the process of photosynthesis is not determined in the Shamkirchay reservoir in winter and in all seasons in the lower bay. However, naturally, the elimination of organic matter in the water continues throughout the year. The formation of primary organic matter begins in early spring, when the water temperature reaches 8-9 ° C, and is recorded in the summer at around 0.6-1.2 mg O_2 / l. Interestingly, the total yield in spring is 2 times less than in summer, and destruction is 7 times less.

10. Microbiological regime of Arpachay reservoir

Due to the lack of settlements in the catchment area, the Arpachay Reservoir, which maintains its natural condition, differs from the reservoirs we have studied in many respects, first of all, in the number, distribution and generation of microbiota. The total number of microbes in water varies from 0.8 to 2.5 million / ml, and in silt - from 0.7 to 2.2 billion / g. According to saprophytes, the average annual values are 1.5 min / ml, respectively; 2.3 million / g. In the basin, in the silt-soil, as in the Shamkirchay reservoir, the physiological group of bacteria is not widespread in the water, because the water is clean.

Table 35

Seasonal changes in temperature (t ° C), transparency (m) and some hydrochemical ingredients (mg / l) in the Appachay Reservoir in 2014

Analyzes	Winter	Spring	Summer	Autumn
Transparency	1.3 ± 0.06	0.3 ± 0.01	1.4 ± 0.06	0.6 ± 0.02
Temperature	0.3 ± 0.01	9.2 ± 0.43	16.3 ± 0.75	11.2 ± 0.45
Oxygen	11.3 ± 0.05	12.0 ± 0.54	9.3 ± 0.44	10.0 ± 0.41
Nitrates	5.3 ± 0.2	6.4 ± 0.31	3.3 ± 0.15	4.8 ± 0.22
Nitrites	0	0	0	0
Phosphates	0.03 ± 0.001	0.08 ± 0.003	0.01 ± 0.0004	0.06 ± 0.002
Ammonium	0.01 ± 0.0004	0.04 ± 0.001	0.02 ± 0.0005	0.02 ± 0.001

The table shows that the transparency of the water changes in spring and autumn, which is due to rain and melting snow. The increase in nitrates also seems to be due to external waters. No complications are observed in the oxygen regime during the year. Sources that adversely affect the transparency of the water body in the reservoir (close to the shores) were not found in areas of soil erosion. Because the shoreline of the Arpachay reservoir is rocky and gravelly, the infiltration of floodplains is very weak and abrasive sediments are formed very little. It is clear from the table that the concentration of mineral nitrogen and phosphorus compounds from hydrochemical ingredients in the Arpachay reservoir is not high. Nitrite compounds were not detected in the water throughout the year, and the concentration of nitrates did not exceed 6.4 mg/l.

Table 36

Photosynthesis of phytoplankton in Arpachay reservoir in 2014 due to the initial product and total organic matter formed Average seasonal indicators of destruction (O_2 mg/l per day)

Station	Winter		Spring		Summer		Autumn	
	PP[1]	D	PP	D	PP	D	PP	D
1	0	0.2	0.2	0.3	1.3	1.4	0.4	1.0
2	0	0.1	0.3	0.4	1.6	1.8	0.5	1.2
3	0	0.1	0.3	0.5	2.0	2.6	0.6	1.3
4	0	0.2	0.4	0.5	2.4	2.6	0.8	1.1
5	0	0.1	0.5	0.6	2.6	3.1	0.9	1.2
Medium	0	0.14	0.34	0.46	2.0	2.4	0.64	1.16

Note: 1. PP - primary product; D - destruction.
2. All results were statistically processed and $P \leq 0.046$

It is clear from the table that phytoplankton does not synthesize primary organic substances in the Arpachay reservoir in winter. The main reason for this is that the water temperature is so low that it freezes. The ratios of the newly synthesized primary organic substances and the organic substrates in the water are almost the same size, based on the "in and out" in 24 hours. The fact that there is no significant difference between the average values shown in the table shows that the production and destruction processes in the Arpachay reservoir are in a regulated state. This, in turn, means that the reservoir is not enriched with organic substances of alloxton origin, and the sanitary-hydrobiological situation in the basin is stable.

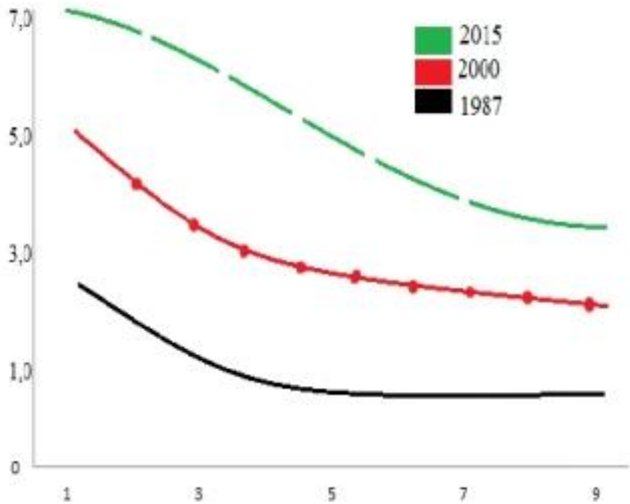
CHAPTER V
MAIN WATER RESERVOIRS OF AZERBAIJAN CONTEMPORARY ECOLOGICAL SITUATION

The results of the research showed that, except for the Shamkirchay and Arpachay reservoirs, all the remaining 8 reservoirs are exposed to some degree of anthropogenic impact. Among them, Nakhchivan, Agstafachay, Shamkir and Mingachevir reservoirs are constantly polluted by transboundary rivers from Georgia and Armenia.

Ashig-Bayramli, Yekakhana and Varvara reservoirs created in our territory according to local sources are polluted by us. However, the main concern regarding the water problem in Azerbaijan is related to the unhealthy condition of the Nakhchivan, Shamkir and Mingachevir reservoirs from an ecological, sanitary and hydrobiological point of view. It has been found that the Kur-Araz rivers and their main tributaries have been continuously polluted for decades, mainly in Georgia and Armenia. In Armenia, whose entire territory belongs to the Araz Basin, the Araz River has become a kind of sewage. It is no coincidence that the average annual amount of coli-enterobacteria in the Nakhchivan reservoir is 11 thousand / ml. It is rare that the number of coli-enterobacteria exceeds that of saprophytic bacteria. Oil-phenols, nitrate-nitrites, phosphates, heavy metal salts, etc. in the basin. The amount of pollutants is 10-12 times higher than YVQ. In the polysaccharide and anthropogenic eutrophic reservoir, the amount of oxygen in the water in summer reaches 1.8-2 mg O_2/l. One of the reasons for the danger of water in the Nakhchivan reservoir is the radionuclides of the Mesamor NPP discharged into the Araz River.

In order to imagine the ecological condition of the Shamkir reservoir, it should be noted that in Georgia, the Kura River discharges an average of 2.4-2.6 km^3 of untreated waste per year. According to Owen (1977), the volume of water in the riverbed should be 30-33 times more than the sewage, in order to neutralize and "dilute" this amount of wastewater in the area of Tbilisi-Rustavi, Mtskheta. According to SHRustamova (1989), the volume of Kura water in the area of these cities does not exceed 8-9 km^3. The average annual rate of fecal contamination in reservoirs is 7.8 thousand/ml, the amount of petroleum phenols is 4.0 and 0.050 mg/l, respectively, which is 10 times higher than the maximum allowable concentration. It was also found that organic and biological pollution in the Shamkir reservoir is increasing year by year (Figure 4).

Number of coliform bacteria (thousand/ml)



Stations

Fig. 4. In summer in Shamkir reservoir number of coliform bacteria.
—— 1987; - □- · - 2000; - º - º - 2015.

Although some information was given about the ecological condition of the Mingachevir reservoir in the 60s and 80s of the last century, in 2015 we conducted more detailed research and the results were compared. It became clear that after the establishment of Shamkir and Yenikend reservoirs in the upper bay, ecological, biological and hydrochemical stability processes in the basin have changed.

First of all, due to the reduction of terrigenous particles (solids), the transparency of water has more than doubled, in shallow waters phytobenthos, higher aquatic plants, phyto-bacterioplankton have developed en masse. It became clear that after the creation of reservoirs on the Kura and Gabirri rivers, it is the Ganikh river that flows freely into the Mingachevir reservoir. Therefore, petroleum phenols, albeit slightly coliform bacteria, relatively high levels of biogenic elements are recorded in the estuary waters of the Ganikh River. The amount of oxygen gas in deep (dam area) water layers (50-60 m) is 2.1-2.4 mg O_2/l. In addition to anthropogenic eutrophication in the basin, alloxton brought from the upper bay (Shamkir and Yenikend reservoirs)

Organic substances and metabolites are the main cause of organic pollution in the Mingachevir reservoir.

Agstafachay reservoir continues at almost the same level. The average annual content of petroleum products and phenols is 1.6 and 0.055 mg / l, respectively. Fecal contamination index - the amount of coliform bacteria varies from 2.4 (winter) to 15.2 (summer) min / ml. Apparently, the Agstafachay reservoir is polluted at the level of polysaccharide and it is impossible to restore its ecological stability (it is severely polluted and poisoned in Armenia). Therefore, the use of water in the home is very dangerous.

The ecological condition of the Varvara reservoir is polysaprobic,mainly due to the sewage discharged from the city of Mingachevir and settements in the basin. The average annual amount of coli-enterobacteria here is 12.8-20 thousand / ml, which is higher than in the Nakhchivan reservoir. It is unfortunate that the waters that form the Lower Kura in our territory are heavily polluted by us.

Thus, it is clear that the safety of 8 of the 10 reservoirs we studied is very controversial. Therefore, the ecologically stable Shamkirchay and Arpachay reservoirs are suitable for domestic use as an alternative, clean water source.

CHAPTER VI
MAIN RESERVOIRS OF AZERBAIJAN BIOLOGICAL IMPORTANT TO THE COUNTRY PRODUCTIVITY OPPORTUNITIES

It can be said that one of the areas of purposeful use of reservoirs created in the world is the development of important biological productivity.

These include primarily fish, snails, algae, crustaceans, mollusks and other hydrobionts.

Acad., who has made great contributions to the development of ichthyology, catfish and hydrobiology in Azerbaijan. A.N.Derjavin (1956) worked very precisely on the development of catfish in the Mingachevir reservoir.

V.Jadin (19460, G.Vinberg (1934, 1960), S.Kuznetsov (1952, 1970) and other,who conducted research in natural lakes and reservoirs for many years have proven that 0.4-0.5% of the initial phytoplankton yield in eutrophic reservoirs is equivalent to a siqnificant fish harvest. For the first time in Azerbaijan, organic matter has been identified in major reservoirs (see Chapter III) and for the first time, fish production potential in the basins has been calculated.

Table 37

Synthesized by phytoplankton throughout the year in reservoirs, Total amount of primary organic matter (thousand tons) and its potential (0.5%) fish product, in centners

Reservoir	Primary organic matter	Fish products
Mingachevir	423.2*	21150*
Shamkir	83.4*	4170*
Nakhchivan	24.6*	1230*
Varvara	16.4*	820*
Agstafachay	20.2*	1015*
Ashig-Bayramli	14.6*	730*
Yekekhana	16.3*	815*

It is clear from the table that if Azerbaijan's large-scale reservoirs are used efficiently, trout fishing will develop in the country, a positive turn will be made in meeting the protein needs of the population, and hundreds of people will be provided with jobs.

RESULTS

1. As a result of ecological, microbiological, sanitary-hydrobiological, monitoring and comparable complex studies, it was determined that all of them are exposed to all kinds of anthropogenic influences in 10 basic water reservoirs created for the first time in Azerbaijan.Based on multi-year and complex results,for the first time the trophic type and degree of saprobity of the researched reservoirs were determined and it was shown that Mingachevir,Shamkir,Aghstafachay,Nakhchivan reservoirs belong to police aprobe reservoirs undergo continuous anthropogenic eutrophication [3,5,7,20,22,25,29,33,34].
2. As a result of the sanitary-hydrobiological and general ecological assessment of reservoirs,it became clear that the sanitary-hydienic situation in reservoirs is unstable depending on the comlex of allochthonous substances entering from the upper basin to the interstices.Due to the intensification of anthropogenic impacts on the Kura and Araz river basins in Georgia and Armenia, the formation and stabilization of ecosystems in the reservoirs receiving transboundary waters has not been possible so far. In the last 60 years, the number of microbes in Mingachevir, Nakhchivan in 45 years, Shamkir in 35 years, respectively, 8; 7; 12 times, primary product of phytoplankton, 6; 4; 5 times, and oxygen consumption - 3; 2; Increased 4 times. It was found that transboundary rivers bring alloxton organic matter, biogenic elements, along with primary eutrophication in reservoirs, to mass vegetation of bacterioplankton, environmental stress in the oxygen regime, hypoxia and stagnant aquatic habitats, anaerobiosis in deep aquifers and silt-soils. created [6,17,23,24,24,25,27,35,41,43,47,48].
3. During the calculation of the balance of organic matter in the studieed reservoirs, it became clear that the mass of total allochthonous organic matter destroyed in all reservoirs is greater than the primary product synthesized by phytoplankton. For the first time, the calculation of the balance of organic matter in the basins, mainly to meet the needs of the population in Azerbaijan

for safe food, especially protein, was based on the possibility of developing their fishing [1,2,10,14,15,25,26,29,47,48].

4. For the first time in Azerbaijan, the microbiological regime, ecological condition and biological productivity potential of the main reservoirs were compared. It became clear that, with the exception of the Arpachay and Shamkirchay reservoirs, anthropogenic eutrophication in the Shamkir, Nakhchivan, Agstafachay, Mingachevir, Yenikend and Varvara reservoirs continues throughout the year, except in winter. Phytoncide phytoncides, intermediates formed in the processes of catabolism, anabolism (H 2 S, CH 4 , H 2 , NH 4 , etc.), which are eliminated during the mass change of forms of phytoplankton and phytobenthos in the short-term vegetation type, have a toxic effect in water [3, 9,10,15,16,18,19,21,25,32,45].
5. From the territories of Armenia and Georgia, 1.8 million m^3 of untreated sewage is discharged into the Araz basin and 2.4 million m^3 into the Kura basin, respectively. Organic pollution of alloxton origin is predominant in Shamkir, Mingachevir and Agstafachay reservoirs due to the fact that the majority of wastewater (75-80%) belongs to the utilities and food industries. The second place in the dangerous level of pollution of these basins belongs to the wastes of metallurgical and chemical industries operating in Armenia and Georgia. Therefore, in the water entering the reservoirs, from the sanitary-hygienic point of view (OMM, OKM) alloxton organic substances are on average 8-11 times higher than the MAC, heavy metal salts (copper, molybdenum, iron, zinc, lead) -6-11 many times [4,6,12,14,17,21,23,25,27,29].
6. The dependence of the physical and chemical properties of water in reservoirs, biological productivity processes, sanitary-hydrobiological condition on the complex of organic substances of alloxton origin, the mass of biogenic elements has been determined. It became clear that due to geographical climatic conditions, microbiota and biogenic impurities are decisive factors in the mass development of phytoplankton-phytobenthos. Hypoxia processes intensify in hot months due to disruption of

oxygen supply in the silt-soils of deep areas, in areas where higher aquatic plants grow in reservoirs, anaerobiosis occurs in many biotopes and hydrofauna, hydroflora-mass destruction occurs [9,10,11,16 , 21,22,24,25,29,30].

7. Due to the sedimentation of solid (terrigenous) sediments brought by the Kura River in the last 35 years in the Shamkir reservoir, a fundamental change in the ecosystem of the Yenikend-Mingachevir reservoirs has been identified. At a distance of more than 200 km between Shamkir, Yenikend-Mingachevir reservoirs (with a river meander), the transparency of the Kura River water was more than 10 times and phyto-bacterioplankton develops in the river ecosystem throughout the year [9,16,18,26,29, 32,35].
8. For the first time, the main reservoirs of Azerbaijan, sanitary-hydrobiological, applied ecology, are evaluated comparatively for extensive, purposeful use of water. The water is used in household, irrigation, technical water, fishing, poultry (water), etc. the direction of use for the purposes is clarified. It is for the first time that the use of Shamkirchay and Arpachay reservoirs as an alternative source can be justified based on the comparison of such complex results [20,21,22,24,25,29,34,36,44].
9. It was found out that Ashig-Bayramli and Yekakhana reservoirs created in the cross-border riverbed are exposed to fecal pollution. Thus, reservoirs in the country are polluted, the same source is used for different purposes, and there are no protective and sanitary areas for the protection of river reservoirs, and the discharge of sewage along the basin is not sufficiently prevented [8,10,11,19,21,25,26,28 , 35,39,47,48].

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